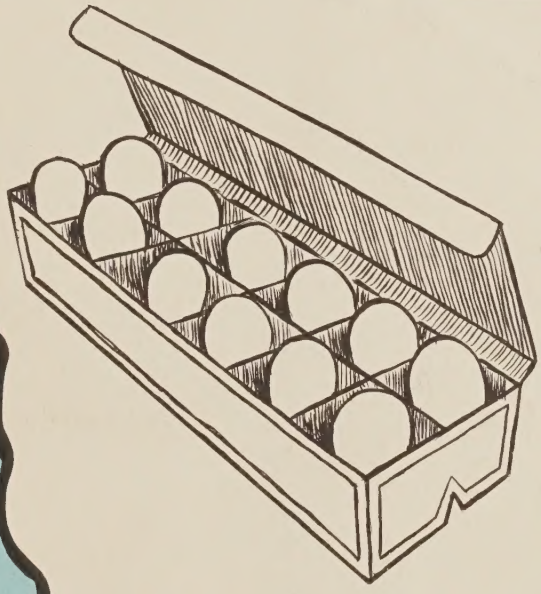
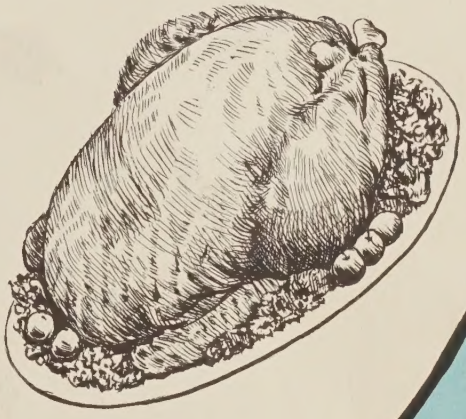
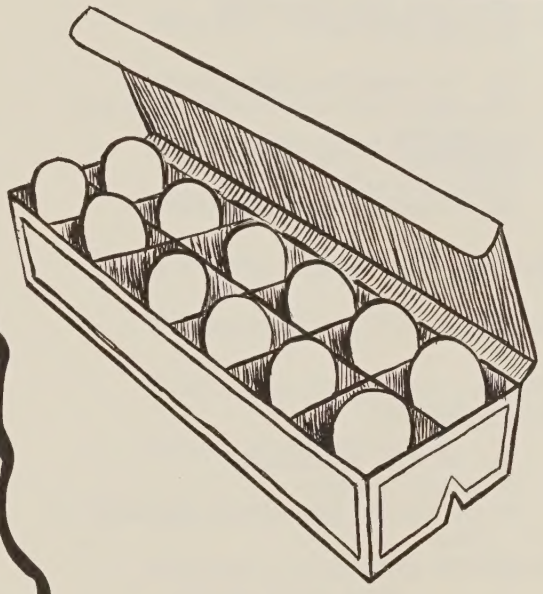
Poultry Research Needs in the Southern Region

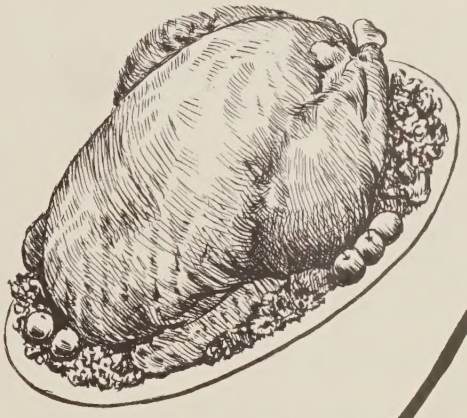




A REPORT OF THE POULTRY TASK FORCE FOR THE SOUTHERN REGION AGRICULTURAL EXPERIMENT STATIONS AND THE UNITED STATES DEPARTMENT OF AGRICULTURE . . . . . APRIL 1972

Poultry Research Needs in the Southern Region





A REPORT OF THE POULTRY TASK FORCE FOR THE SOUTHERN REGION AGRICULTURAL EXPERIMENT STATIONS AND THE UNITED STATES DEPARTMENT OF AGRICULTURE . . . . . APRIL 1972

MEMBERS OF THE SOUTHERN REGIONAL POULTRY RESEARCH TASK FORCE

I. Participation from State Agricultural Experiment Stations[1/]

Dr. Robert M. Brewer
Assistant Professor of Pathology
Department of Poultry Science
Auburn University
Auburn, Ala.
(Task Force Vice Chairman)

Dr. E. L. Stephenson
Head of Department
Department of Animal Sciences
University of Arkansas
Fayetteville, Ark.

Dr. Henry R. Wilson
Associate Professor of Physiology
Department of Poultry Science
University of Florida
Gainesville, Fla.
(Task Force Secretary)

Dr. Morley G. McCartney
Chairman of Poultry Research Division
Department of Poultry Science
University of Georgia
Athens, Ga.

Dr. A B. Watts
Head of Department
Department of Poultry Science
Louisiana State University
Baton Rouge, La.

Dr. Rollin H. Thayer
Professor Poultry Nutrition
Department of Animal Science
Oklahoma State University
Stillwater, Okla.

Dr. B. D. Barnett
Head of Department
Department of Poultry Science
Clemson University
Clemson, S. C.

Dr. Herschel V. Shirley, Jr.
Associate Professor of Physiology and Genetics
Department of Poultry Science
University of Tennessee
Knoxville, Tenn.

Dr. John Quisenberry
Head of Department
Department of Poultry Science
Texas A & M University
College Station, Texas
(Task Force Chairman)

II. Participation from USDA Agricultural Research Service

Dr. Arthur J. Mercuri
Chief of Animal Products Laboratory
R. B. Russell Agricultural Research Center
Athens, Ga.

Dr. William F. Talburt
Assistant Director
R. B. Russell Agricultural Research Center
Athens, Ga.

III. Representative for Cooperative State Research Service

Dr. George J. Mountney
Research Management (Food Science)
U. S. Department of Agriculture
Cooperative State Research Service
Washington, D. C.

IV. Representative for Southern Agricultural Experiment Station Directors

Dr. C. O. Little
Associate Director
Kentucky Agricultural Experiment Station
University of Kentucky
Lexington, Ky.

[1/] The contributions of Dr. R. K. Noles, Associate Director of Resident Instruction, College of Agriculture, University of Georgia; Dr. I. J. Ross, Department of Agricultural Engineering, University of Kentucky; and Dr. E. P. Roy, Department of Economics and Agribusiness, Louisiana State University, are also gratefully acknowledged.

CONTENTS

PREFACE

The Agricultural Experiment Station Directors of the Southern Region at a meeting in April 1970, elected to activate a regional Poultry Research Task Force. This Task Force was initiated as a mechanism to begin developing coordinated and cooperative programs relative to state and federal research bodies in the Southern Region.

Each Southern State Agricultural Experiment Station Director, the Cooperative State Research Service and the USDA Agricultural Research Service were asked to name representatives to the Task Force if so desired. Thirteen individuals representing a broad cross section of disciplines knowledgeable of the poultry industry in the South were appointed to formally constitute the Task Force.

Members of this Task Force have evaluated the importance of the poultry industry in the South, examined critical needs and problems, projected future trends, identified researchable problem areas, and recommended research approaches pertinent to better serving this viable industry. The report that follows summarizes the immediate results of this Task Force effort and is intended to serve as a guide for scientists and administrators as to what needs to be done and why. It should be recognized that the content of this report is only a judgment of Task Force participants at the time of preparation. It is hoped that continual monitoring of the industry to identify new areas of research will follow and that thorough administrative study for coordinating implementation will result.

Poultry Research Needs in the Southern Region

INTRODUCTION

"Truly, the poultry industry of today is a great industry. And it is as different from the poultry of yesterday as that of tomorrow promises to be different from that of today."[1]

The domestic chicken was introduced into America by the early settlers of this continent. In a country abounding with wild game, including the native turkey, chickens proved to be of little commercial interest. Small flocks were allowed to roam the farmsteads in hopes that eggs would be available during the spring. As the towns and cities grew, small flocks were kept by the farmer's wife who used the eggs when bartering for other needs. These small flocks formed the basis for the early commercial egg industry. By the late eighteen hundreds, quantities of eggs produced on a large number of these small farms made up regular rail shipments of eggs moving to eastern metropolitan markets.

During the first 40 years of this century a number of inventions, discoveries, and innovations led directly to the development of the modern poultry industry. The mass production of chickens was made possible with the invention of the forced-draft incubator, the discovery of vitamins, the discovery of vaccines and medications to control diseases, notably coccidia, the practical application of chick sexing and the development of a modern transportation and communication system. One should also recognize that the business environment was such that it permitted the development of the multi-stage industry into a business structure now known as the integrated firm.

Thus, the poultry industry in the United States grew slowly through the first 125 years. With the meshing of the innovations mentioned earlier, it exploded in the 20th century. By 1970 the gross income to the producers of eggs, broilers, chickens (other than broilers) and turkeys in the United States exceeded 4,263 million dollars.[2] Eggs grossed 2,202 million dollars, or 51 percent of the income from the four major poultry commodities consumed in this country. Broiler income reached 1,462 million dollars (34 percent), chickens (other than broilers) 107 million dollars (3 percent) and turkeys 492 million dollars (12 percent).

Poultrymen in the thirteen southern states, Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Oklahoma, Louisiana and Texas, have shared in the growth and development of this industry. Gross income in these states during 1970 was 2,203 million dollars or 52 percent of the gross income from poultry and poultry products in the United States. Income from eggs was 959 million dollars or 44 percent of the income to poultry in the 13 states. Broilers grossed 1,037 million dollars (47 percent); chickens, 58 million dollars (2 percent); and turkeys, 149 million dollars (7 percent).

Output of these commodities has expanded rapidly in this area and is continuing to expand. Egg production in the 13 states increased from 28,186 to 28,614 million eggs from 1969 to 1970, an increase of 438 million eggs. During the same period, pounds of broilers produced (live weight) increased from 7,460 to 8,078 million pounds, up 617 million pounds. The 558 million pounds of chicken (other than broilers) produced in 1970 was up only slightly from the 553 million pounds produced in 1969. Turkey production rose from 609 million pounds in 1969 to 673 million pounds in 1970.

The spectacular increase in production in the South and the United States is mirrored by the statistics on per capita consumption of these products over the past 10 years. The increase in broiler

---

[1]Monthly Letter to Animal Husbandmen, Armour's Livestock Bureau, Armour and Company, Chicago, Ill., Vol. 9, No. 9, Dec. 1928.

[2]Statistics used are from current issues of Poultry and Egg Situation, ERS, USDA; and Eggs, Chickens and Turkeys SRS, CRB, USDA.

consumption has been the most sensational. Per capita consumption in 1960 was 23.4 pounds. By 1970 consumption had increased to 37.3 pounds.

There are two other aspects of this industry which must be mentioned. The first is the rapidly changing structure of the industries involved in the production of these commodities. A striking example of this change is found within the hatchery industry. In 1961 there were 3,525 chicken hatcheries and 621 turkey hatcheries in the United States. Setting capacity averaged 144,400 and 80,100 eggs, respectively. On Jan. 1, 1971, there were 1,209 licensed chicken hatcheries and 252 turkey hatcheries. Average setting capacity had risen to 368,500 chicken eggs and 195,500 turkey eggs. This changing business structure associated with the innovations of changing technology is a way of life within the industry.

Finally, this industry is so immense and so thoroughly integrated with allied industries that its contribution to the total gross national product is difficult to measure. The 4,260 million dollars in gross income is nearly one-tenth of the gross income from all farm commodities. If a ratio of 1 to 5 to increase the monetary impact of this industry on our economy is used, then the production of poultry commodities contributes more than 17 billion dollars to the national economy.

In a rapidly growing industry, projections of future production and consumption are subject to serious error. In 1964 USDA economists[3] estimated that 1980 production of chicken and turkey meat would be 11.49 billion pounds. By 1970 the production of chicken meat alone was in excess of 12 billion pounds. There is no reason to believe that the phenomenal rate of growth of this industry will not continue into the coming decade. Present estimates are that by 1980 U.S. egg production will increase 7 billion eggs to 77 billion. Per capita consumption of poultry meat, up from 34.1 pounds in 1960 to 49.7 pounds in 1970, will exceed 60 pounds per capita even if a reduced rate of expansion is projected.

Thus, the poultry industry that has proved to be the most dynamic agricultural industry in the past decade can look forward to progress in the coming decade.

This has had an important bearing on the economic growth of the South and research holds the key to continued economic growth and development of the poultry industry in the future.

RESEARCH PERSPECTIVES

Over the past 20 years the poultry research in the United States, when measured by cost benefit ratios, has been one of the most productive research endeavors financed by state and federal agricultural agencies. In this same period, the Southern Region has become the most important poultry producing and processing area in the United States.

The momentum which has made the poultry industry a viable and profitable one, despite many severe setbacks, has also made it possible for producers to sell poultry for about two-thirds of the price they received 40 years ago. The poultry industry has also set the pace for other areas of the livestock industry and has served as a standard of efficiency by bringing about revolutionary innovations in integration, management, production and processing.

Benefits from completed poultry research are still accruing as they are adopted by the industry. For example, in 1971 successful vaccines were developed for immunization against Marek's disease. It has been estimated that when it becomes practical to vaccinate all broilers, the use of this one practice alone will result in adding as many as 5 percent more broilers to our total meat supply simply by reducing mortality rates and condemnations.

The development of machines to debone uncooked poultry meat without destroying the major functional properties of the meat has resulted in poultry meat low enough in price that it competes with red meats for use in sausage and bologna. Other uses for this type of meat and improvements of the deboning process continue under intensive investigation. It has been predicted that revolutionary new management systems where broilers will be raised entirely in cages are only 10 years away. If such

---

[3] A National Program of Research for Poultry. USDA unnumbered publication dated November 1968.

systems can be perfected, it has been calculated that a conventional 36 x 200 foot house which can handle 40,500 broilers a year on the floor will be able to accommodate 123,000 birds in cages.

Similar exciting new developments are underway in other areas of the industry. These present and potential developments tend to support the comment made by K. L. Blaxter, a visiting English scientist, who described the United States poultry industry as "--one of the most amazing pieces of integrated work that has ever been done." At the present time, the end of this productive era in the poultry industry is not yet in sight and new developments are limited only by the imagination and aggressiveness of the scientists and the input of sufficient resources to continue the momentum already generated.

The eight basic subject matter areas, or disciplines, outlined in this report encompass the broad spectrum of research effort in poultry. The specific problem areas outlined under each section represent the most pressing needs for research as seen by the Task Force and by no means is meant to be all inclusive.

As the poultry industry has grown and become more complex, so has the need for cooperative planning and execution of research. Group research will be necessary to solve and integrate many problems involved with efficient production, processing and marketing of poultry products. This approach, and its accomplishments, is characterized by the recent breakthrough in the reduction of losses from Marek's disease in chickens. Individual departments may not have sufficient qualified staff to make major contributions in all areas of poultry research, but may need to concentrate on areas where particular expertise is available.

Research scientists must be increasingly aware of the economic impact of their research. In this regard, more cooperative effort with all segments of the poultry industry will be necessary to solve many of the complex problems facing us. Environmental control and management, nutrition, disease control, husbandry, genetics and waste handling present unique problems in the extremely large production units used today, which will have to be solved by a combination of basic and field research. This effort will require cooperative projects between industry scientists and station personnel, as well as cooperative work with all governmental research agencies.

An ever-increasing problem in food-animal production is environmental pollution. This encompasses both animal wastes and chemical materials used in feed and for insect and disease prevention and control. Plans for all future research projects will have to include provisions for determining the impact of the project on pollution abatement. Research must provide the knowledge to produce poultry and poultry products in a manner that will not add to pollution of the environment. Advancement of the poultry industry will depend to a great extent on success in accomplishing this objective.

INFERENCE

1. Through application of technology and utilization of resources, the poultry industry has provided a source for major economic development in the Southern Region while furnishing wholesome, competitive food items for the consumer.

2. Continued development and further realization of the growth potential of this industry is contingent on new knowledge and technology applicable to increasing consumer demands of poultry and eggs and strengthening economy of production.

3. Attainment of the needed new knowledge and technology will be realized only through multidisciplinary research with system approaches to the problems and potentials.

4. Immediate research priorities should include (a) increasing consumer demands through identification of product acceptance criteria, improved product quality and development of new products; (b) more economical production systems through improved breeding, feeding, housing, management, processing and marketing; (c) pollution abatement through development of physical and chemical systems of control, better utilization and improved recycling mechanisms; and (d) disease control and prevention through biologic, chemical, genetic, and environmental processes.

5. Long range research priorities should be directed toward (a) strengthening the pricing structure for poultry and eggs; (b) improving the nutritional profile of poultry products; and (c) expanding the physiological potential of the bird.

6. Concentration of research efforts will accelerate future accomplishments. Present diversification of manpower and resources are not conducive for readily identifying centers of excellence. The various participating agencies in the Southern Region should begin immediately to identify the general subject areas for which they have unique competence so that implementation of concentrated coordination can be developed.

GENERAL SUBJECT AREAS

HOUSING, EQUIPMENT AND ENVIRONMENT

The major research needs in the area of housing, equipment and environment were considered to be: housing type and design, equipment arrangement and manure management for layers; cage production for broilers; light regimes; bird responses to environmental stresses and changes; competitive position of the Southern Region in relation to housing and environment; and management of turkey breeders in cages. Many of these problems will also be of vital interest to those working in the areas of waste, reproductive and environmental physiology, processing and products development. Related research will be found in most other areas of poultry production.

Title: Design of Housing and Equipment to Minimize Problems of Manure Management in Commercial Egg Production.

Situation: Great progress has been made in recent years on improving labor efficiency by mechanization of egg production However, no completely satisfactory method of manure disposal has been incorporated into this system. This is especially true when evaporative cooling is employed due to moisture added by this system. In that labor efficiency is a major consideration of any housing system, large units are necessary to take advantage of economies of labor. The construction of large units of different types on experiment station farms is economically unfeasible, thus cooperation with manufacturers on commercial farms may be necessary. The development of poultry operations that are efficient, that can be located near centers of population and that are free from nuisance complaints should result in a more efficient industry.

Objective: To develop or identify the combination of housing type, equipment arrangement and manure management that will minimize nuisance aspects of poultry production and maximize production efficiency.

Research approach:

A. Study labor efficiency, equipment capability and manure management of latest style commercial egg operations.

B. Compare deep pit houses with those designed for daily manure removal.

C. Study feasibility of air-drying manure in cage houses with several manure removal systems.

D. Study feasibility of cooling houses by refrigeration to avoid moisture addition and wet manure problems.

E. Develop improved liquid manure handling systems.

F. Develop improved methods for fly, rodent and odor control.

Title: Production of Broilers in Cages.

Situation: Broiler production in the Southern Region has expanded rapidly and has become mechanized so that labor involved in production is efficient. Two factors have remained relatively unchanged in

the history of the industry: (1) birds are housed on the floor and (2) catching for market is a hand operation. Use of cages should permit more birds per house and allow transport to market without catching. It has been estimated that with the use of cages three times as many broilers could be produced per unit area as in a conventional house. The development of a satisfactory system that would eliminate the need for catching crews would also resolve one of the serious labor problems of the broiler industry. Breast blisters and bone fragility on cage-reared birds appear to be the most serious obstacles.

Objective: To develop systems for producing broilers that utilize the house more efficiently and that reduce or eliminate need for catching crews.

Research approach:

A. Develop cages and management systems that can be used to grow and transport broilers to market and that do not result in breast blisters and fragile bones.

B. Develop efficient system of arranging and handling cages with minimum manure removal cost.

C. Compare cage handling systems with conventional systems in relation to cost, market quality and nuisance production.

Title: Catching and Moving Broilers to Market.

Situation: The movement of broilers from the production site to the processing plant remains a hand-labor operation and the most difficult job to keep staffed. The unpleasant hours, dirty working conditions and hard work make this a job to be avoided by those workers in a position to choose. The labor that is available is therefore relatively undependable and careless. This results in scheduling difficulty and in more bruises and losses than when good handling practices are used. The development of a mechanical bird handling system would reduce or eliminate the serious labor problem in catching market birds. Bruising, mortality and downgrading associated with transporting should be reduced as well.

Objective: To develop a system of broiler production adaptable to mechanized marketing or to develop a completely mechanized catching and cooping system.

Research approach:

A. Study production of broilers in housing systems designed for easy bird removal.

B. Study mechanical catching, handling or moving systems designed for low labor requirements.

C. Develop new systems.

Title: Light Regimes for Poultry Production.

Situation: The use of totally enclosed, force ventilated houses for production of poultry has provided the industry with the potential for manipulating light intensity and photoperiods to a greater extent than previously possible. Limited use of controlled lighting has been utilized to control sexual maturity of off-season turkey and chicken breeders. Providing a minimum of 14 hours light for laying chickens has been standard procedure. A thorough investigation of the intensity, wave length and combination of light and dark periods is needed. It may be possible to improve efficiency and market quality by light manipulation. Energy wasted by birds in activity may be channeled into eggs and meat by appropriate manipulation of light. Tenderness of meat may be enhanced by reduced muscular activity. Time of oviposition may be regulated by light to permit more efficient use of labor and egg gathering equipment. Fertility and hatchability problems may be reduced by improved light control of the environment of both males and females.

Objective: To use the physiological stimulus of light to produce high quality poultry meat and eggs in the most efficient manner possible.

Research approach:

A. Study the effect of light intensity on rate of production of poultry meat and eggs.

B. Study the effect of different wave lengths on the rate of production of poultry meat and eggs.

C. Study the effect of different intervals of light and darkness on sexual maturity, growth rate, market quality and time of oviposition.

D. Study the effect of light on toms and roosters with emphasis on sexual maturity and duration of fertility.

E. Study the relation of light to other environmental factors, including temperature and caretaker activity as they relate to production of eggs and meat.

F. Study behavior as influenced by light.

G. Design structures with more effective lighting.

Title: Production Equipment for Broilers.

Situation: Large scale feeding and watering equipment systems have been developed for conventional, floor rearing of birds. This equipment has been designed more from a materials handling standpoint than from the needs and preferences of the birds. The crowding of birds, as would be expected in expensive controlled environment housing, may render present feeding and watering systems inadequate. The development of a system that is fully functional from day-old to marketing age would reduce stresses of changing from one system to another. An evaluation of the feeding and drinking preferences of the broiler chick, especially in modified environments, is needed.

Objective: To develop feeding and watering equipment that will promote maximum performance of birds in high-density houses where light may be subdued.

Research approach:

A. Various shapes, sizes, locations and mechanically different watering systems should be compared. Adaptability to the chicks' changing size should receive attention.

B. The supplying of feed in different systems should be studied. Emphasis should be on high density housing in controlled environments.

Title: Physiological Responses to Environmental Stresses and Changes.

Situation: The development of technology that permits a considerable degree of environment control within poultry houses raises many questions. Among these are: (1) What is the ideal temperature for production of broilers, layers and turkeys? (2) What are the effects of extremes of temperature such as might occur during power failure or equipment malfunction? (3) What is the ideal relative humidity or ideal temperature:humidity relationship? (4) What are the effects of air movement and relationship of air movement to temperature? (5) What are the effects of sound of different frequencies and intensities? (6) What are the effects of dust? (7) What are the effects of elevated levels of carbon dioxide, ammonia and other gases that might be present? Several states in the Southern Region have environmental chambers in which one or more of these factors can be studied. The industry can design buildings to modify the environment of commercial birds if improvement in performance justifies the cost. At present, performance data are generally lacking. Industry is plunging into environmental control. With only limited information available, serious and expensive errors are possible.

Objective: To determine the optimum range of environmental conditions for poultry production and the effects of extremes that might occur in commercial practice.

Research approach:

A. Birds of the different species and ages should be subjected to a range of temperatures that will bracket the range of optimum performance as determined by growth rate, feed consumption, reproduction and other appropriate physiological measurements. Both short- and long-range trials should be conducted and adaptability should be explored.

B. The relationship of humidity to temperature should be explored through a wide range of temperatures and dew points as they relate to bird performance.

C. The effect of air movement on birds of various ages should be studied under a variety of temperature conditions.

D. The response of the several species of birds to sound frequencies and intensities should be determined under both short-term and long-term conditions.

E. The dust prevalent in poultry houses should be characterized and any effect on the bird determined.

F. The level of ammonia, CO_2 and other gases in commercial houses should be determined. The physiological effects of these gases should be determined under controlled conditions.

Title: Competitive Position of Housing Systems in the Region.

Situation: The Southern Region has long been presumed to be in a favorable competitive position compared with other poultry production regions because of lower housing and labor costs. With the advent of highly mechanized production systems utilizing temperature controlled housing, some of these advantages have been reduced. The relative advantages of labor and housing in different regions needs clarification. The location of new plants will be determined in part by the competitive advantages of the different regions. A clearer definition of these advantages will allow intelligent growth and expansion of the different segments of the poultry industry.

Objective: To determine the effect of different housing and equipment systems on the competitive position of the region.

Research approach:

A. Determine the portion of the cost of production that is chargeable to housing, equipment depreciation and labor.

B. Study the cost of production in different production systems within the region.

C. Compare the cost of poultry production within the Southern Region to other regions of the country with particular concern to labor, housing and equipment costs.

Title: Management of Turkey Breeders in Cages.

Situation: The confinement of breeder turkeys in cages seems to offer some of the same advantages observed in production of commercial chicken eggs. Included among these advantages are reduced labor, greater control over management, reduction of internal parasites and certain diseases, ease in controlling exposure to light and clean eggs. In addition, the turkey hen is confined for easy artificial insemination. The widespread adoption of cages for turkey breeders cannot be achieved until more information is available.

Objective: To develop a cage system for turkey breeders that permits economical production of a large number of poults per breeder.

Research approach:

A. Develop cages that are mechanically sound for large birds. This includes a determination of (1) size for space economy, (2) size of wire needed to support birds, (3) slope required for egg "roll out," (4) mechanically sound artificial insemination procedures within cages.

B. Develop adequate feed, water and egg removal systems.

C. Determine effect of cages on broodiness.

D. Learn methods of minimizing egg breakage.

E. Study effect of cages on nutrient requirements.

WASTE MANAGEMENT

The research needs in waste management are considered to warrant high priority. The prevention of pollution and/or conversion to a useful product are of major importance to all production units, hatcheries and egg and poultry processing plants. Related research needs are also listed in Housing, Equipment and Environment, Processing and Product Development, Nutrition and Feed Technology and Genetics and Breeding.

Title: Evaluation of Waste Management Systems

Situation: Much of the research on poultry fecal waste has been devoted to waste characterization and treatment unit evaluation. A continuation and expansion of these efforts are needed. However, as more basic information becomes available for use in design, techniques for evaluating the usefulness of this information in real systems must be developed. With the availability of high speed computers and the mathematical tools of operations research, systems analysis and modeling should be an integral part of the design, analysis, and comparison of alternative waste treatment systems.

Objective: To develop modeling techniques for determining the technical and economic feasibility systems of poultry waste management.

Research approach:

A. Develop computer models to evaluate alternate systems for poultry waste management on the basis of cost analysis and the potential for environmental pollution.

B. Develop models that will provide a tool for analysis and design of waste disposal systems for particular production schemes.

C. Define constraints which will be imposed on systems design such as regulatory criteria, quality of water required for production of acceptable feedstuff in a recycling scheme, and other factors related to air and water emissions associated with particular treatment systems.

D. Collect, or establish by synthesis, cost and operational data on methods of utilizing or disposing of poultry manure in forms that can be used in computer modeling.

Title: Recycling Poultry Manures Through Animals.

Situation: Poultry manure can be used as an animal feed component. Recycling may be within or across animal species. The possibilities of recycling poultry wastes are encouraging. Birds excrete approximately 45 percent of their dry matter intake. It has been shown that a significant portion of this excreta can be recycled as a feed either to the bird or to ruminates. Recycling not only provides a potential means for disposing of waste, it also provides an opportunity for significant improvement in overall feed efficiency and conservation of feed resources.

Objective:

A. To determine the nutritional value of poultry manure and the effect of processing the manure on its nutritional value.

B. To produce an acceptable feedstuff from manure with no hazard to human or animal health.

Research approach:

A. Determine the usefulness and limitations of manure as animal feed by defining its nutritional value through chemical analysis and feeding trials.

B. Determine the nutritional properties of manure as affected by diet, age, and cultural and breed characteristics of the birds.

C. Determine the effect of various processing techniques such as heat treatment and drying on the nutritional properties of manure.

D. Develop processing techniques such as fermentation and extrusion which enhance the nutritional value of manure.

E. Determine the usefulness of manure as a food for insects as a means of final disposal or stabilization and as a means of recycling through other animals.

F. Identify components of manure which may present a hazard to human or animal health such as pathogens, pesticides, medicinals, or other deleterious materials and determine acceptable levels of these components and means for controlling or maintaining these acceptable levels.

Title: Recycling Waste Through Soil-Plant Systems.

Situation: Recycling manure to the land has been a traditional method of disposal. The purpose of this method is not only the management of waste in a manner consistent with improving or maintaining environmental quality, but also to gain economic return from plant nutrients in the waste. At present where suitable land is available, it is probably the best method of disposal. However, placing manure back on the land can create potential soil and water pollution problems by infiltration to ground waters and in surface runoffs. Nutritional problems from plants receiving manure fertilizer have also been identified and seem to be associated both with plant growth and the health of animals eating the plants. Treatment system effluents such as those from lagoons and oxidation ditches are being placed on the land as a final disposal site. The fertility, chemical, and physical effects of these effluents on the soil need to be determined.

Objective: To determine the optimum and maximum loading rates of manure and treatment system effluents on soils which are compatible with optimum plant and animal production practices and which create no environmental pollution hazards.

Research approach:

A. Determine the rates of degradation of various components of manures and treatment system effluents and the rates of accumulation of compounds resulting from the presence of these wastes in the soil and their relation to the basic chemical, microbiological, and physical properties of these wastes; to the soils in which they are placed; and to environmental conditions.

B. Determine the optimum and maximum loading rates of manure on the land as governed by surface and ground water quality standards, crop yields, crop quality, and effects on soil properties including the accumulation of plant nutrients, trace elements, and salts.

C. Determine the effects of various loading rates of manures on the soil and on crop quality and yield as evaluated by feeding trials and chemical analyses of the crops produced.

D. Determine alternative methods of odor abatement by treatment of manure prior to or after land application or by placement in the soil.

E. Identify and monitor residual components, microbes and pests that may present nuisances and hazards to human and animal health and develop means of control.

Title: Waste Treatment Systems.

Situation: Treatment systems utilize microbial fermentation to degrade the organic compounds in waste. This degradation may occur in dilute systems such as lagoons, oxidation ditches, or activated sludge systems, or in soils when waste are injected or spread on the surface. With these systems, the desired end result is to dispose of the waste -- no directed attempt is made to derive any potential benefit from it. Treatment systems are used in production facilities which are characterized by large numbers of birds being grown and maintained in relatively small areas with a general absence of land on which the manures can be spread effectively. It may be the only alternative available to many producers.

Objective:

A. To determine the ability of various treatment systems to degrade waste as affected by environmental conditions.

B. To determine the maximum loading rates of poultry waste that can be used in treatment systems to prevent pollution of runoff and ground waters and the atmosphere.

Research approach:

A. Determine how various environmental, chemical, and physical factors influence the rate of microbial degradation and residue accumulation of fecal waste in solutions and in the soil and relate this information to basic chemical and physical properties of the wastes and the microbial populations in the disposal media.

B. Determine and monitor residual components from treatment systems that may present nuisances and hazards to human and animal health and the environment, and determine the methods for controlling these.

C. Determine the effect of alternate treatments of animal wastes on odor abatement and develop means for odor control.

D. Define the potential pollution problems associated with leakage from treatment systems and develop methods for control.

Title: Properties of Manure.

Situation: Investigations relating to the basic physical, thermal, and chemical properties and microbiological characteristics of poultry manure need to be continued and intensified. This information is needed for the design and development of disposal and recycling systems. It will provide the impetus for and the insight into the development of new products from poultry wastes and the development of new processing and handling equipment and methods. It will also provide a basis for the development of pest and odor control techniques which are of major concern in the Southeast.

Objective: To determine the basic physical, thermal, and chemical properties and the microbiological characteristics of poultry manure.

Research approach:

A. Determine the basic chemical properties of manure and relate these to diet, age, cultural and breed characteristics of the birds.

B. Determine the physical and thermal properties of manure and solutions of manure such as density, specific heat, thermal conductivity, and viscosity and relate these properties to the basic chemical properties of manure.

C. Determine the characteristics of manure as a growth media for microbes and relate these to basic chemical and physical properties of the manure.

D. Determine the physical drying, dewatering, and storage characteristics of manure and relate these to basic chemical and physical properties of the manure and develop drying and storage systems.

Title: Improved Technology for Abatement of Water and Air Pollution and Efficiency of Water Use in Poultry and Egg Processing Plants.

Situation: The processing of poultry and eggs results in the generation of large volumes of water that are contaminated with soluble and insoluble organic and inorganic materials. Viscera, blood, feathers, offal, fecal material, eggshells, egg contents, detergents, sanitizing materials, etc. enter the plant effluents which are discharged into municipal sewage systems, to lagoons adjacent to processing plants, or directly into nearby waterways. Public outcries for a cleaner and more healthful environment have resulted in government regulations limiting volume and strength of pollutants entering sewage treatment plants or being discharged directly into streams. Surcharges and fines are being imposed on processors when these limits are exceeded. Odors emanating from lagoons and/or from poultry by-product rendering plants are frequently offensive and often arouse public complaints followed by legal cease and desist injunctions. Closely allied to the waste

disposal problems is the problem of dwindling water supplies. The cost of clean water for poultry processing operations -- as much as 16 gallons per broiler processed -- will soon become prohibitive. New or improved processing methods and equipment are needed that will (a) result in more efficient use of water for processing, (b) substantially reduce volumes and strength of plant effluents, (c) diminish odors from poultry by-product rendering operations, and (d) allow for more efficient recovery of useful by-products.

Objective: (a) To minimize water and air pollution from poultry and egg processing plants and from poultry by-product rendering plants. (b) To increase the efficiency of water use for processing of poultry and egg products.

Research approach:

A. Develop improved processing techniques and equipment that will minimize the volume and strength of waste in plant effluents.

B. Develop processes for extracting soluble and insoluble organic and inorganic materials from processing waters and provide means for recycling of such waters.

C. Develop food and nonfood uses for recovered waste materials and by-products.

D. Evaluate changes in processing proposed for improved waste utilization for their effects on product quality.

REPRODUCTION AND PHYSIOLOGY

Some major physiological problems where additional research is needed are egg formation (especially the shell), infertility, environmental stress and decline of egg production with age. More basic research is needed in areas of sex determination, hormone levels and regulation, ovulation mechanisms, embryology, and behavior. Many interrelationships exist between physiology and housing, nutrition, pathology and other areas.

Title: Reproductive Performance and Physiology of Poultry.

Situation: Although reproduction in commercial stocks of chickens and turkeys has been improved considerably in recent years, there are still many problems that need to be solved to obtain maximum efficiency in reproductive performance. Low reproduction in meat stocks of chickens and turkeys is still a serious problem. The inability of broiler breeders and turkeys to reproduce at more efficient levels has resulted in high chick and poult costs. This has resulted in a loss in potential income to the producer of hatching eggs and to the hatchery. In general, the low reproductive performance is largely attributed to two factors: egg production over a relatively short reproductive period, and inadequate fertility and hatchability. Consequently, there is a need to redefine the problems in terms of identifying the major breakdown in the reproductive processes and then evaluate and identify as many factors as possible that might be responsible for the low reproductive performance.

Reproduction in stocks of chickens for the production of commercial table eggs needs to be improved, particularly from the standpoint of reducing the replacement cost of pullets. This might be accomplished by increasing intensity or extending the reproductive cycle from the present 12 to 15 months to 18 to 24 months or providing a controlled environment that will allow birds to lay at a high rate for a longer period of time. In addition to improving the intensity and persistency of commercial egg stocks, emphasis needs to be placed on the improvement of internal egg quality, including the possibility of selection for lower cholesterol level in eggs.

Basic research needs to be expanded to provide physiological information necessary to improve the entire productive efficiency of poultry. This includes research in males in the areas of semen physiology, preservation and artificial insemination techniques and in females in the areas of physiology of ovulation and egg formation. In general physiology research affecting both sexes, should include environmental physiology, behavioral physiology, sex control mechanisms, quantitative and qualitative determinations of levels of circulating avian hormones, and physiology of incubation and embryology.

Objective: To develop methods for the improvement of reproductive performance of poultry.

Research approach:

A. To increase the level of reproductive performance of broiler and turkey breeder stocks, including egg production, fertility, hatchability and chick and poult production and quality.

B. To improve the techniques of artificial inseminations and to develop methods for the preservation of semen of chickens and turkeys.

C. To improve the intensity and persistency of egg production and interior and exterior egg quality characteristics of commercial egg production stocks of poultry.

D. To determine the circulating levels of avian steroid hormones, e.g., prolactin, estrogen, leutenizing, follicle-stimulating, in chickens and turkeys both quantitatively and qualitatively and to relate these to improvement in reproductive performance.

F. To develop methods for the production of the desired sex of chicks and poults by the manipulation of exogenous hormones or any other physiological methods that might make it possible to control sex in chickens and turkeys.

G. To study the effects of all factors that might affect interior and exterior egg quality, such as temperature, nutrition, management, age and genetics, and to determine if physiological and biochemical changes in the reproductive system of the fowl are associated with losses in egg quality during the reproductive period.

H. To evaluate the role of behavioral physiology in improving the reproductive performance of chickens and turkeys.

PATHOLOGY AND PARASITOLOGY

Research needs in the area of poultry diseases have been identified in the following areas: parasite-caused diseases, viral and bacterial diseases, fungal diseases and toxicities and pathological reactions caused by other factors. Cooperative research is needed with the areas of housing and equipment, processing, physiology and others.

Title: Coccidiosis Control.

Situation: Clinical and sub-clinical outbreaks of coccidiosis remain one of the biggest deterrents to efficient production of poultry meat and eggs. After prolonged usage, many coccidiostats become ineffective due to development of resistant strains of coccidia or to changes in environment and management systems. Insufficient immunity in commercial layers and breeders results in unthrifty birds, increased culling, mortality and poorer egg production. More effective and efficient control measures for this disease are needed if maximum performance is to be achieved.

Objective: To develop and evaluate new coccidoistats and coccidiocides and to determine systems of immunization which will assure maximum protection for production birds.

Research approach:

1. Develop new compounds which will be efficacious against all species of coccidia, produce negligible resistance in the parasite, and be free of residue and environmental pollution hazards.

2. Study several regimens for immunizing production flocks against coccidia and integrate these with other management programs.

3. Develop additional methods of in vitro cultivation of coccidia, and develop systems of using these cultures in basic research, as well as in drug screening programs.

4. Continue to study and define life cycles of new species of coccidia in other fowl such as quail, turkeys, wild birds, etc.

Title: Control of Other One-Celled Internal Parasites of Poultry.

Situation: Internal parasites such as histomonads, trichomonads, leucocytozoan and others may cause occasional heavy losses in poultry flocks, but generally are the source of chronic losses by preventing the maximum performance of the flock. Continuous use of chemicals for control of these diseases is not practical since many of them are a result of complexes with other diseases or intermediate hosts. Emphasis must be given to biological and environmental control of these parasites.

Objective: To develop new methods for control of unicellular parasites of poultry and to determine the interrelationships of these parasites with environmental factors and with other diseases.

Research approach:

1. Study the pathogenesis, spread and control of these diseases under various environmental conditions.
2. Develop biological control methods for intermediate hosts such as black flies.
3. Develop further in vitro culture methods for these parasites which could be used to study the basic biological processes, as well as control measures.

Title: Control of Helminths in Poultry.

Situation: Most broilers and turkeys and many layers are housed in dirt- or concrete-floored houses. Under these conditions, helminths are always present. They present a constant challenge to peak performance by competing with the host for nutrients and by serving as a source of intestinal irritation which may allow other infections to gain access to the bird. More detailed information on the role of these parasites in triggering and complicating other disease processes is needed.

Objective: To determine the effect of helminth upon the hosts' ability to withstand challenge with other disease organisms and to attain maximum performance.

Research approach:

1. Determine the effect of various environmental regimens on the ability of various helminths to cause damage in poultry.
2. Study the interrelationships of helminth and other diseases such as coccidiosis and the enteritis complex.
3. Develop more efficient control methods for certain genera of helminths such as Capillaria.

Title: External Parasites of Poultry.

Situation: External parasites still cause widespread problems in the poultry industry. Chiggers plague the turkey industry by producing skin lesions which cause downgrades at the processing plant. Mites and lice have been suspected of acting as carriers of other diseases but there is a lack of evidence for this belief. Concentrated housing of layers in cages has compounded problems with these parasites. Research should be done to establish definite control measures without causing further residue problems.

Objective: To develop and refine control measures for external parasites, involving chemical, environmental and management factors.

Research approach:

1. Develop new prophylactic and therapeutic agents for the control of chiggers on turkeys.
2. Study the effects of various management regimens on reducing downgrading resulting from chigger damage on turkeys.
3. Study interrelationships between external parasites and other diseases. Also, determine the effect of various environmental systems on these parasite populations.

Title: Wholesomeness of Poultry Products.

Situation: Millions of pounds of poultry meat and products are condemned each year because of the presence of disease processes. This condemned product may be an organ, limb, or a whole carcass. Very little has been done to attempt to reclaim this product after the disease has been overcome by the bird. A more basic understanding of the nature and cause of condemnation and of ways to eliminate it is necessary for maximum yield of high quality poultry.

Objectives: To determine the effect of various disease processes on the tissues and systems of poultry and their effects on wholesomeness of the final product.

Research approach:

1. Study the biological responses involved in conditions which result in condemnation or downgrading of poultry, such as breast blisters, malformed hocks or other joints, infected feather follicles or feather tracts, and barebacks resulting in damaged tissue.
2. Elucidate a meaningful basis for microbial, chemical and physical quality assurance which could be performed quickly, easily and objectively.
3. Study the effect of early diseases such as coccidiosis on uniformity, picking qualities, bleed out, etc.
4. Study possible new problems which may cause downgrading and condemnation at future times.

Title: Environmental Hazards in Relationship to Disease.

Situation: Congestion of the poultry industry and increased size of production units have created conditions conducive to rapid and destructive spread of diseases. High level use of pesticides on food crops and around poultry houses has led to contamination of some feed and poultry by-products. Residues of these pesticides may lead to condemnation of the product since no tolerance level has been established in some cases.

Objective: Determine the effect of pesticide residues and various atmospheric and solid pollutants on the ability of poultry to remain healthy and perform normally.

Research approach:

1. Seek to establish tolerance levels for all classes of compounds widely distributed in the poultry industry and verify the safety of these levels.
2. Determine effects of various levels of pesticides on the ability of chickens to withstand challenge with various disease organisms.
3. Study the interrelationships of various diseases and atmospheric pollutants, such as ammonia and carbon dioxide.
4. Study the effects of chemical and mineral pollution of drinking water upon flock health.

Title: Marek's Disease Study.

Situation: Marek's disease has caused millions of dollars damage to the broiler industry during the past few years. This disease, which is characterized by lymphoproliferative tumors of internal organs, skin, muscle and nerve tissue, has been found to be caused by a herpes virus. Recently, techniques have been worked out for immunizing chickens by using a non-pathogenic herpes virus found in turkeys. These findings have done much to help alleviate the severe economic losses but may not be the answer to the important question of bringing the disease under control. It is essential to develop methods of control which will reduce the amount of challenge to a point where good management practices will keep the disease under control.

Objective: To study the mechanism by which the herpes virus induces tumor formation, the mechanism of immunity and the effect various environmental and biological factors have on these processes.

Research approach:

1. Determine the mechanism of viral-induced malignancy in chickens.
2. Study the mechanisms of immunity to Marek's disease in chickens and develop systems of vaccination for field use.
3. Develop methods for rapidly detecting genetically resistant stock.
4. Determine the importance of various environmental stress factors in the onset and spread of Marek's disease.
5. Explore the possibility of chemical control.

Title: Lymphoid Leukosis in Chickens.

Situation: Recognition of lymphoid leukosis as a disease separate from Marek's disease has been well established. The former is a disease primarily of adult stock and causes substantial losses in mortality and reduced egg production. At the present time, no vaccine has been found effective against this disease. It is spread vertically from infected dams and may also spread from bird to bird. Further effort must be made to develop methods for successfully controlling this disease.

Objectives:

1. Continue basic work on the etiological agent of the disease and study the effect of environmental variables on its onset.
2. Seek methods of control, including vaccination, genetic resistance, and management.
3. Further clarify detection methods and methods for differentiating between lymphoid leukosis and Marek's disease.

Title: Studies on Virus-caused Respiratory Diseases in Poultry.

Situation: Virus diseases, including infectious bronchitis (IB), Newcastle disease (NC), Influenza A, and Laryngotracheitis, cause significant losses each year. Certain of these diseases such as IB and NC are a double hazard in that they may trigger other infectious agents to cause disease outbreaks. Sporadic outbreaks of these diseases may cause severe losses in broilers and layers. Variant Newcastle strains have reached epidemic proportions in some areas in 1971. Further studies on the factors which affect the occurrence and spread of these diseases must be carefully studied, along with improved methods of control.

Objective:

1. Study the epidemiology of these virus diseases and determine the effects various environmental factors have on their occurrence.
2. Identify and differentiate variant strains of these viruses and explore their use in vaccines.
3. Test the role of genetic resistance in control of these diseases and determine the interrelationship between genetic resistance and management systems.
4. Improve basic diagnostic techniques and develop basic information needed for differential diagnosis.

Title: Studies on Commonly-occurring Non-respiratory Viral Diseases.

Situation: Fowl pox, infectious bursal disease (IBD), and avian encephalomyelitis (AE), are widespread in the poultry industry. They may occur sporadically as in the case of AE and Pox or become a chronic problem on a farm as is the case with IBD. These diseases cause heavy economic losses each year in growing and laying stock and must be continually monitored. Improved methods of vaccination and control need to be studied and applied.

Objective: To study the etiological agents of these diseases and to develop improved methods of control.

Research approach:

1. Conduct studies on the causative agents to determine their biological characteristics and immunologic responses.
2. Develop improved methods of control through such factors as vaccination, environmental management and chemotherapeutic agents.
3. Monitor the spread and occurrence of these diseases in an effort to prevent severe outbreaks.

Title: Control of Chronic Respiratory Disease in Poultry.

Situation: Chronic respiratory disease is caused by a group of organisms (Mycoplasma) which are intermediate in size between viruses and bacteria. Mycoplasma gallisepticum has been found to be the primary cause of CRD. Stress or complicating agents, such as infectious bronchitis, Newcastle disease, and E. coli, are usually involved in the infection under field conditions. Recently it has been found that Mycoplasma synoviae can cause respiratory infection in chickens and Mycoplasma meleagridis is suspected. A combination of blood testing and breeder stock selection has resulted in Mycoplasma negative stock in many instances. These and other methods of control must be studied and exploited to bring these diseases under control.

Objective: To study the pathogenicity, method of spread, immunology and environmental control of the mycoplasmas and to refine methods for their prevention and control.

Research approach:

1. Explore the various diagnostic procedures, with emphasis on differential diagnosis of the various serotypes.
2. Study the interrelationships between Mycoplasma and the environment of the poultry house.
3. Explore the possibility of using variant serotypes of Mycoplasma as immunizing agents.
4. Evaluate the role of other species of birds as possible reservoirs of Mycoplasma.
5. Study the role of genetic resistance in control of these diseases.
6. Study the interaction between the mycoplasmas and biological stresses, such as E. coli, IB, NC, etc.
7. Evaluate possible chemical control measures.

Title: Mycotic Infections of Poultry.

Situation: Toxins formed by growth of certain fungi in feedstuffs cause loss of weight, poor efficiency and death in poultry. Bulk handling of feed ingredients and the storage of bulk feed on poultry farms create an ideal situation for mycotoxin production. These toxins, especially alfatoxin, have been shown to cause tumor formation in otherwise healthy birds. Careful study of the nature of fungal toxins and their role in the onset and spread of poultry diseases should be explored.

Objective: To determine the nature and effect of mycotoxins in bulk poultry feed and to study the effect of these toxins on the onset and spread of poultry diseases.

Research approach:

1. Study the basic physical and chemical properties of all classes of mycotoxins.
2. To determine the effect of various levels of these toxins on the performance and health of poultry.
3. Explore the possible role these toxins play in inducing tumor formation in birds and study the mechanism of this process.
4. Study the effect of diseases such as aspergillosis on poultry and develop better methods of control.

Title: Other Diseases Affecting Poultry.

Situation: There are numerous other diseases of economic importance to the poultry industry. These diseases may vary in intensity according to season, geographical location, or other causes. All of these, however, continue to pose an economic and public health threat. They are: (1) Fowl cholera, (2) Salmonellosis, (3) Bluecomb, (4) Ornithosis, (5) Erysipelas, (6) Infectious synovitis and others. Many of these diseases are controlled generally by careful management, but additional research effort should be placed on more reliable forms of control.

Objective: To determine the cause and effects of these diseases and to develop means of control.

Research approach:

1. Study and improve methods of differential diagnosis.
2. Explore methods of detection of these diseases as contaminants of human food.
3. Study methods of prevention and treatment.
4. Determine geographical occurrence and establish patterns to be used in eradication or control.
5. Study interrelationships with such factors as nutrition, genetics, and environment.

Title: New Disease Monitoring Program.

Situation: The congested nature of the poultry industry has created conditions ideal for the mutation or genesis of new disease problems. A constant monitoring program should be followed for early detection of these problems.

Objective: To be alert for possible new disease problems and to conduct basic studies to determine their control.

Research approach: Diagnostic laboratories should be on the alert for new disease conditions and variations of existing ones. They should immediately alert research personnel to the problem and help begin emergency research to determine ways to halt spread.

NUTRITION AND FEED TECHNOLOGY

Many advances have been made in nutrition of poultry; however, research on nutrient requirements should be continued due to the changing genetic makeup, environmental stresses and the lack of information in some areas. Research in mineral metabolism, especially in relation to shell and bone formation, is needed. Feed contaminants, wastes, ingredient testing procedures, feed formulation techniques and interrelationships of nutrition with product composition and quality, diseases, genetics and other factors need to be considered. Special attention should be paid to new ingredients, especially those produced locally or in the Southern Region.

Title: Eggshell Quality as Determined by Interrelationships Among Calcium, Phosphorus, and Other Nutritional Factors.

Situation: After laying hens have been in egg production for prolonged periods, substantial economic losses occur due to cracked, checked, broken, and soft-shelled eggs. In some instances it would appear that the inherent ability of the laying hen to assimilate calcium and phosphorus has been altered genetically and these minerals are not utilized efficiently. This may be due to the fact that mineral intake requirements for calcium and phosphorus, as well as trace minerals, may be significantly different in the commercial hybrid, which is being produced through poultry breeding today, or there may be some malfunction in mineral metabolism at the cell or tissue level. Environmental stress brought about by high population density or drastic variations in environmental temperature and humidity may be related to this problem. A detailed evaluation of mineral metabolism in the avian species in relation to eggshell quality needs to be made in order to obtain data which may make it possible to correct poor shell quality under practical feeding conditions.

Objective: To evaluate mineral metabolism in the avian species as it is related to eggshell quality under practical commercial feeding conditions.

Research approach:

A. Study calcium and phosphorus metabolism in those commercial hybrids where eggshell quality becomes a critical problem after four to six months of egg production.

B. Calibrate intake requirements in present day commercial hybrids in order to determine those levels and ratios which will maximize calcium and phosphorus utilization in eggshell formation.

C. Determine if vitamin intakes for all vitamins related to mineral metabolism are adequate for maximum efficiency of mineral utilization under present-day commercial production conditions.

D. Study the relationships of different types of environmental stresses upon mineral metabolism as they are related to eggshell quality, particularly after sustained periods of lay.

E. Determine normal pattern in mineral metabolism under commercial production conditions in relation to eggshell quality as it may take place during the entire laying period, beginning with the onset of lay and continuing through 15 to 18 months of egg production, and compare this pattern to that observed when eggshell problems are encountered.

Title: Calorie to Amino Acid Ratios in Practical Rations for Laying Hens.

Situation: A considerable research effort has been expended in studying calorie to protein ratios as they are required in layer rations under practical feeding conditions. These ratios are critical in that they regulate protein intake per hen per day and determine whether sufficient protein will be provided for efficient egg production. However, a very important consideration in this connection is the amino acid quality of the protein which is ingested. Some research work has been initiated on calorie to amino acid ratios, but research work in this area needs to be expanded. If adequate data were available, it is entirely possible that judicious supplementation with synthetic amino acids might increase manyfold the efficiency with which current protein sources could be utilized for egg production. This would have economic significance in that current shortages of certain essential protein supplements might be eased and new sources of high quality protein made available.

Objective: To determine calorie to amino acid ratios for single amino acids and combinations of amino acids which will maximize protein utilization for egg production at a minimum protein intake per hen per day.

Research approach:

A. Determine calorie to amino acid ratios for methionine and lysine.

B. Determine calorie to amino acid ratios for the 3rd through 18th limiting amino acids as found in practical layer rations fed under current feeding conditions.

C. Study the feasibility of utilizing synthetic amino acids to improve efficiency of protein utilization.

D. Determine feasibility of utilizing protein sources considered to be low in protein quality by giving more attention to calorie to amino acid ratios and by supplementing them with synthetic amino acids.

Title: Nutrition of Breeder Turkeys in Floor and Caged Environments.

Situation: Considerable research with turkey breeders has been done, and progress has been made in improving efficiency of reproductive performance as influenced by nutrition. Under current production conditions, turkey breeders are normally housed in a floor environment. A management practice has been adopted in Europe in which turkey breeder hens are housed in laying cages. Turkey producers in the United States are considering the possibility of adopting this management procedure in their own operations. However, at the present time very little basic data are available on the management practices which should be followed with breeder turkeys in this type of

environment and nutrient intake requirements have not been delineated. The general acceptance of the management practice of maintaining turkey breeders in cages could significantly reduce poultry cost and substantially reduce the overall cost of producing market turkeys of all classes. Even when turkey breeders are maintained in a floor environment, available nutrient intake data are not adequate to produce hatching eggs with maximum efficiency. Research on nutrient intake requirements with both floor and caged breeders needs to be intensified to meet anticipated demands for critical data.

Objective: To study in depth the nutrient intake requirements of breeder turkeys in both floor and caged environments.

Research approach:

A. Determine protein and energy intake requirements of caged turkey breeders.

B. Study mineral and vitamin intake requirements in relation to established energy and protein intake requirements.

C. Study nutrient intake requirements of turkey breeders in both floor and caged environments when a recycling management procedure is followed which gives turkey breeders a rest-period in early summer and brings them back into egg production in the fall.

D. Determine nutrient intake requirements which will maximize reproductive performance during hot climatic conditions as encountered in the South during the summer months.

Title: Nutrient Intake Requirements of Game Birds of All Classes.

Situation: A review of the literature indicates that considerable research on the nutrient requirements of game birds was done during the 1950's and early 1960's. However, research in this area needs to be initiated again, expanded in scope, and requirements expressed on an intake basis. This work should involve all nutrients with particular attention being directed towards those phases of mineral metabolism which involve shell quality. There is an increasing interest in the raising of game birds for pleasure, as well as on a commercial basis for meat purposes. With the current emphases on environmental pollution and wild game preservation, the growing of game birds in confinement will take on added importance in the immediate future.

Objective: To evaluate the present status of nutrient requirements for game birds and to study in depth nutrient intake requirements for all nutrients.

Research approach:

A. Determine protein and energy intake requirements for all classes of game birds.

B. Study mineral and vitamin intake requirements in relation to established energy and protein intake requirements for all classes of game birds.

C. Study calcium and phosphorus intake requirements and their interrelationship with vitamins and trace minerals as related to eggshell quality.

D. Determine survival of both young and adult birds.

E. Study feeding practices to increase the production or persistence period.

Title: Utilization of Yeasts, Algae and Other Single-cell Proteins as Major Protein Sources and Amino Acid Supplements in Poultry Rations.

Situation: Protein concentrates with high amino acid quality, such as fish meal, are frequently in short supply and quality is extremely variable. There is a need to develop protein concentrates which can be produced at extremely low cost and which will recycle waste materials in the manufacturing procedure. For example, in Europe, yeast is being produced on hydrocarbon wastes and the data and experience which are available indicate that cost is low and nutritive value high. Some attention is being directed toward this problem in the United States, but more effort needs to be expended in expanding the research now underway. Preliminary research from a number of

laboratories indicates that yeast and other single-cell proteins of the proper strain can provide many essential amino acids, as well as other nutrients, and can make up a major portion of the total protein intake. If adequate procedures can be developed for manufacturing and desirable nutrient composition obtained by selecting the proper yeast strains, a substantial reduction in feed cost could be realized.

Objective: To develop manufacturing procedures using low-cost, readily-available substrates; to select strains which will grow on these substrates and produce desired nutrient composition; and to conduct feeding tests and determine the nutrient value of these materials in all types of poultry rations, both as an amino acid supplement and as the major source of protein.

Research approach:

A. Select strains which will grow on synthetic substrates made up of pure chemical compounds which can be manufactured from basic elements.

B. Develop fermentation procedures which will maximize product output.

C. Evaluate these products from both a nutrient composition standpoint and their nutrient value in poultry rations of all types.

D. Determine if there are any undesirable physiological effects or toxic reactions when these products are fed.

E. Study the feasibility of using these products either as amino acid supplements with regular protein concentrates or as the major source of protein.

F. Study the feasibility of making combinations of strains or modifying a given strain to produce nutrient composition to meet predetermined standards.

Title: Southern Forages as Xanthophyll Sources.

Situation: Consumer preference dictates that the skin and fat of market poultry contain a certain degree of yellow pigment in the form of xanthophyll. A number of xanthophyll concentrates are available on the market and rations are formulated to contain such ingredients as alfalfa leaf meal and corn gluten meal which are natural sources. Many forages are grown in the South which could be dehydrated and used in this way. A systematic approach needs to be made to this problem in order to explore possible sources and to study their efficiency as xanthophyll agents. It is entirely possible that there are sources of xanthophyll-containing ingredients in the form of southern forages which could be made available. By developing potential sources, a substantial reduction in the expenditure for xanthophyll supplements could be made.

Objective: To evaluate available southern forages which could be grown and processed for use as xanthophyll supplements in poultry rations.

Research approach:

A. Study the actual xanthophyll content of southern forages which can be produced in adequate quantities.

B. Evaluate these forages in terms of nutritive value in all types of poultry rations.

C. Evaluate the xanthophyll properties of these forages in terms of the final product (meat and eggs).

Title: Processing of Potential Feedstuffs for Poultry.

Situation: There are many potential feedstuffs for poultry which are indigenous to the Southeast, but which would need to be processed properly in order for them to be used in poultry rations. It is very possible that many of these feed ingredients, if properly processed, would provide low-cost nutritious feeds for poultry and could replace more expensive ingredients now used. Work in this area should make it possible to bring about a substantial reduction in feed costs as related to production of poultry meat and eggs. It should also help to relieve the pressure brought about by increasing demands on certain feed ingredients which are in short supply.

Objective: To select certain feedstuffs which are indigenous to the Southeast and which are not now used in poultry feed and to develop technology for the processing of these feedstuffs to make them into low cost nutritious feeds for poultry.

Research approach:

A. Evaluate potential feedstuffs from both a nutritional and an economic standpoint with the purpose in mind of selecting those which could be used most effectively in poultry rations.

B. Determine which processing procedures would provide the best final product.

C. Develop technology which would be economically feasible in the production of these feedstuffs in large quantities.

Title: Improving Nutritive Value of Feedstuffs by Processing (Corn, Milo, Small Grains).

Situation: Considerable work has been done on the enzyme treatment of barley to improve its nutritive value for poultry. Processing techniques of a similar nature are being studied intensively in the preparation of corn, milo and small grains for the feeding of beef cattle under feed lot conditions. Improvements in nutritional values obtained through these processing procedures could be of real economic significance in bringing about the more efficient utilization of the nutrients in grains. Based upon the data which are available with barley, it would appear that a similar line of research could be developed which would improve the nutritive value of these grains for all classes of poultry. In addition, research data indicate that pelleting does improve the nutritive value through the breakdown of the basic structure in certain feedstuffs and this evidence indicates that much more can be done in this area. This research should involve not only processing procedures now being used for other classes of livestock, but should involve the development of new approaches.

Objective: To develop technology which will improve the nutritive value of corn, milo, and small grains for use in poultry rations.

Research approach:

A. Expand research involving the addition of enzymes to feed ingredients during the processing procedure.

B. Utilize procedures of processing now involved in the preparation of grains for beef cattle feeding and use these approaches as a base in the development of new processes for application in the preparation of grains for poultry feeding.

Title: Metabolic Malfunctions in Poultry Under Practical Production Conditions.

Situation: Under the intensive commercial production conditions as practiced in the United States in the poultry industry at the present time, serious nutritional problems become apparent which seem to have no simple solution. These problems may be brought about by alterations in the genetic makeup resulting from the intensive breeding programs being carried out by commercial breeders. Within this situation, the metabolism of certain nutrients may be altered to the detriment of the poultry or nutrient intake requirements and interrelationships drastically changed. Examples of apparent metabolic malfunctions include the "Fatty Liver Syndrome" as it is encountered with laying hens in cages and the apparent malfunction in calcium metabolism which is being encountered with certain commercial hybrids under practical conditions. No satisfactory solution of these problems is anticipated until a better understanding of the basic metabolic functions involved is determined. In many cases very little is known concerning these functions in avian species. Research in this area must of necessity include a delineation of the basic physiological function involved, the determination of deviations from a normal sequence in function, and the relating of these data to the problem as it is encountered under practical feeding conditions. The two problems cited constitute major economic losses to the poultry industry and need immediate solution. It is anticipated as genetic changes are brought about through intensive poultry breeding that many more problems of this type are likely to be countered. This is more likely to occur as new management procedures are developed and put into practice.

Objective: To study apparent metabolic malfunctions as they become apparent in poultry being produced and maintained under practical commercial production conditions.

Research approach:

A. Study basic physiological procedures in sufficient detail to provide a normal base for study of specific problems in depth.

B. Determine the precise metabolic sequence for a given nutrient as it normally occurs under practical conditions.

C. Determine the precise sequence of metabolic events which takes place with a given nutrient when the problem appears under practical feeding conditions and relate this back to the normally expected sequence.

D. Relate these basic data to the problem and develop practical recommendations to correct the situation.

Title: Alteration of the Energy, Protein, Amino Acid, Vitamin, and Mineral Composition of Grains and Plant Protein Sources.

Situation: In many instances with plant materials, it would be desirable to alter nutrient composition through breeding to provide specific nutrients at predetermined levels. For example, high lysine corn makes it possible to overcome some of the formulation difficulties encountered in manufacturing poultry feeds. Energy intake and the relation of energy intake to the intake of other nutrients is becoming more and more important in poultry nutrition. It would be desirable to be able to increase or decrease the energy content of plant materials, as found in the form of starch and fat, in order to meet better predetermined intakes. In addition, some combination of feedstuffs may bring out specific amino acid deficiencies which require supplementation either through feed ingredients or by synthetic amino acids. If the amino acid ratios, in particular the level of specific amino acids, could be altered in grains including corn, milo and wheat, it would be possible to eliminate these deficiencies without added expense. For these reasons, it is desirable that a definite well-planned program of plant breeding be initiated to develop varieties with predetermined nutrient compositions.

Objective: To develop grain varieties and plant protein concentrate sources with nutrient composition to meet specific nutrient specifications.

Research approach:

A. Determine what alterations in nutrient content are needed to meet current formulation problems.

B. Evaluate the feasibility of providing these through plant breeding.

C. Initiate plant breeding programs in cooperation with plant breeders to provide nutrients as specified, with high priority being given to those most urgently needed.

D. Evaluate crops available around the world which might be suitable for production in the United States and which have specific nutrient levels in line with current demands.

Title: Hazards from Mycotoxins, Chemicals, and Bacterial Contaminants in Feed Ingredients Used to Formulate Poultry Rations.

Situation: Emphasis is being placed upon the elimination of feed contaminants in the form of mycotoxins, chemicals, and bacteria as they find their way into feed ingredients in the normal sequence of production and processing. It is evident that more stringent standards will be put in effect in the foreseeable future. It is desirable that specific contaminant problems be thoroughly studied as they appear under practical feed processing and feeding conditions with the goal in mind of eliminating the contamination and removing the health hazard. It would appear that mycotoxins produced by fungus and mold in wet grains, contaminants in the form of chemicals such as insecticides, and bacterial contamination in the form of Salmonella are the most pressing at this

time. However, it is likely that even though solutions are found to these problems, additional ones will come to the attention of poultry research scientists as time goes along. These problems will need to be dealt with on an individual basis as they appear.

Objective: To identify potential hazards and to insure contaminant-free poultry rations.

Research approach:

A. Identify production and storing procedures that minimize the growth of fungi and molds in feed grains.

B. Determine tolerance levels which will permit feed ingredients to be used, even though contaminated, without endangering efficiency of production or the health and well being of the poultry or consumer involved.

C. Determine those insecticides which are metabolized by poultry when they are present in feedstuffs.

D. Develop bactericides and recommendations for their use which will permit them to be included in poultry rations as a regular ingredient.

E. Eliminate or minimize bacterial contamination if it occurs.

Title: Changing Nutrient Composition and Flavor of Meat and Eggs by Altering the Nutrient and Chemical Composition of Poultry Rations.

Situation: Nutrient intake levels for human beings are constantly being revised in terms of their relationship to the development and incidence of certain pathological conditions. Immediate interest involves cholesterol and the levels of saturated and unsaturated fatty acids which are to be found in poultry meat and eggs. A great deal of information and misinformation is being distributed for public consumption. The true facts need to be firmly established insofar as meat and eggs are concerned in relation to cholesterol, fatty acids and other nutrients. Unless this is done, per capita consumption of poultry products will drop and economic pressure will be put on poultry producers. In addition, in those areas where facts are not available, research needs to be initiated to obtain essential data in order that this information can be used intelligently by the medical profession and dieticians in recommending human diets.

Objective: To determine if the chemical composition of meat and eggs can be altered through nutrition in such a way as to produce both poultry meat and eggs according to a predetermined nutrient composition and flavor standard.

Research approach:

A. Study ways and means to alter the cholesterol content of eggs.

B. Study ways and means of altering the fatty acid composition of poultry fat.

C. Obtain basic data on lipid metabolism in the avian species and utilize these data for altering the flavor and nutrient composition of meat and eggs.

Title: Develop Methods to Reduce the Amount and Volume of Poultry Manure Produced and to Recycle It Efficiently.

Situation: Large volumes of poultry manure are produced by poultry each year. This manure is excellent fertilizer and can be applied effectively to improve the fertility of arable land. However, there is a limit to the amount of poultry manure that can be disposed of in this way. It would be very desirable if ways and means could be found to reduce the volume of the manure by increasing the efficiency with which feed is utilized. It may be that clay and bentonite in the ration could be instrumental in reducing volume. Research studies need to be initiated to improve efficiency of nutrient utilization, and in so doing, reduce the amount of waste which must be recycled. In addition, technology must be developed for recycling the poultry manure through poultry or other livestock as a feed ingredient in the regular ration. Studies of this kind have been done with beef cattle, and to some degree, with poultry.

Objective: To reduce the volume of poultry manure produced and to find improved procedures to recycle it through poultry and animal feeds.

Research approach:

A. Study nutrient density in terms of feed weight and volume as these factors are related to volume of manure produced.

B. Study inclusion of ingredients or additives in poultry feeds with the purpose of reducing volume of waste.

C. Investigate the possibility of utilizing poultry manure as a feed ingredient in poultry feeds to provide protein, minerals, and vitamins.

D. Investigate the possibility of processing poultry manure and utilizing it as a major ingredient in rations for swine and beef cattle.

E. Secure information that would support requests to FDA for approval to recycle wastes through animals.

Title: Ingredient Quality, Ingredient Combinations, and Economic Considerations Related to the Formulation of Poultry Rations.

Situation: The entire problem of least cost rations for poultry involves not only ingredient cost per se, but ingredient quality, the combining ability of two or more ingredients, feed to food ratios, and the efficiency with which mills can be operated in the mixing operation. All of these factors have a bearing upon total ration costs, and in return, are reflected in the overall cost of producing poultry meat and eggs. Nutrient evaluation of specific feed ingredients needs to be done more accurately in order that an efficient job can be done in formulating rations by hand or computer. Nutrient values vary from sample to sample and there is no quick reliable way to get an accurate estimate about the ingredients which are actually to be used in a specific ration. In addition, factors involving handling and storage have an effect on quality and these need to be evaluated. There is always a problem of quality control insofar as individual feed ingredients are concerned and in relation to the complete ration after it has been mixed. This area of ingredient quality control needs a great deal of attention. The entire area of ingredient combinations needs to be explored in order that basic data can be made available to feed formulators. Much attention has been directed towards determining nutrient intake requirements, but very little attention has been given to the entire problem involving which ingredient combinations would best supply these nutrient intakes. In the area of efficiency of nutrient utilization, studies need to be made to determine feed to food ratios in order that the most efficient use can be made of the available feed ingredient supply. The technology of feed mill operations needs to be studied in relation to mixed feed needs in a given area of production so that the entire milling operation can be coordinated to reduce milling costs to a minimum.

Objective: To study problems involving least cost formulation, ingredient quality, and efficiency of mill operation as these factors relate to the overall cost of producing poultry rations.

Research approach:

A. Develop ways and means of quickly and accurately estimating the nutrient content of feed ingredients.

B. Study the effect of handling and storage on feed quality.

C. Develop technology required to control quality of feed ingredients and mixed feeds.

D. Study ingredient combinations in order to determine the most effective combinations to efficiently meet nutrient intake requirements.

E. Study possible integration procedures among feed mills in an area to maximize efficiency of feed mixing and distribution.

F. Evaluate the entire problem of feed to food ratios in order to determine the best ratios from the standpoint of both nutrition and economics.

Title: Nutrition, Genetic, Disease, Environment, and Management Interrelationships.

Situation: It is impossible to study any aspect of the nutrition of poultry without considering genetics, disease incidence, environmental conditions under which these rations are to be fed, and management practices. All of these singly or in complex combinations have an effect upon nutrient requirements. As genetic improvements are made in poultry through intensive poultry breeding nutritional requirements change. The incidence and severity of diseases of different kinds must be taken into consideration in determining nutrient intakes for maximum productive performance. Climatic conditions, as well as population density in poultry houses, will determine nutrient intake requirements, depending upon the conditions present. As management procedures change and management systems are developed to take care of poultry from day-old through the entire production period by automation, there will be a significant effect upon nutrient requirements and interrelationships. This entire problem has an important bearing upon the economics of poultry meat and egg production and studies need to be initiated to cope with current problems, as well as to anticipate problems in the immediate future.

Objective: To initiate studies, to evaluate the current situation, and to project research data and needs in the area of the nutrition of poultry as it is related to genetics, disease incidence, environmental conditions, and management practices.

Research approach:

A. Evaluate nutritional requirements as determined by the genetic potential of current commercial hybrids.

B. Study the nutrient intake requirements of poultry as influenced by current disease problems, and obtain basic data which can be used to solve nutrition-disease relationships as they become apparent.

C. Study nutrient intake requirements for different stages of production as they are related to environment.

D. Determine if environmentally-controlled conditions are most economical if nutrition problems can be adequately met.

E. Determine nutrient intake requirements as determined by density of population.

Title: Developing Feed Processing Technology and Ration Supplementing Procedures to Improve the Digestibility of Feed Nutrients.

Situation: Progress has been made in decreasing the amount of feed required to produce a pound of meat or unit of eggs by increasing nutrient density, combining nutrients more effectively, and delineating more precisely nutrient intake requirements. Some research has been done in the area of increasing the efficiency of nutrient digestion in the intestinal tract with the thought in mind of increasing the efficiency of nutrient utilization in relation to the amount of meat or eggs produced. In many feedstuffs there are antimetabolites which inhibit enzyme action in the digestion process. It is entirely possible that the addition of enzymes to the complete ration in such a way that they are activated in the intestinal tract would aid in overall digestion. In many instances with other classes of livestock, the processing of feed ingredients to make nutrients more readily available to digestion processes is paying dividends and increasing nutrient utilization. A great deal of research along this line needs to be developed and work should be initiated. An approach of this kind would not only reduce cost through the more efficient use of nutrients in the feeds, but would reduce the amount of waste material, and in turn, would be of benefit in the area of pollution control. In both ways, this would be of economic importance.

Objective: To develop ways and means of improving digestibility for use under practical feeding conditions.

Research approach:

A. Evaluate the problems involved with antimetabolites and determine areas where research is needed.

B. Expand research already underway in the areas of enzyme additions to include all enzymes related to feed digestion.

C. Explore processing procedures now used with livestock feeds and determine their adaptability to poultry rations in improving digestibility.

D. Study the problem of optimum pH for enzyme action in the digestive tract.

E. Determine what factors are involved under practical feeding conditions in complete digestion.

PROCESSING AND PRODUCT DEVELOPMENT

Research emphasis should be placed on product quality, nutritional value, and the development of new poultry and egg products. New methods are needed for catching, handling, processing, and packaging poultry. Cooperative work is needed with housing and equipment, nutrition, waste, pathology, and marketing areas.

Title: Evaluation and Maintenance Of Quality of Ready-to-Cook Poultry and Shell Eggs.

Situation: The quality of poultry and eggs reaching the consumer can be markedly influenced by off-farm handling practices (e.g., catching and hauling of live birds, methods of cooling, washing, and oiling of shell eggs), processing conditions (method of scalding, defeathering, eviscerating, washing, chilling of poultry), as well as packaging and distribution conditions. Shell eggs frequently lack uniform quality and are often cracked, broken, may have watery whites, exhibit mottling, off-colored yolks, or other defects. Chilled poultry carcasses at the retail level may exhibit excessive, unsightly moisture; bruised areas; sliminess; dryness; or off-odors. Toughness and off-flavors also occur too often, particularly with frozen turkeys. Handling, processing and packing methods need to be improved so that the highest possible level of quality of these products will be maintained throughout the marketing channels. This will also require the development of reliable, preferably objective, methods for ascertaining various quality factors of both poultry and eggs. Such methods can be used for detecting and segregating products according to quality (grading), for predicting storage life, and for evaluating the effect of changes in processing methods or equipment on product quality.

Objective: To develop improved methods of handling, processing, and marketing of poultry and eggs to insure maintenance of optimum quality through marketing channels.

Research approach:

A. Shell Eggs:

1. Establish optimum conditions for collecting, cooling, washing, oiling, and packing of shell eggs to minimize interior quality deterioration and to provide freedom from microbial invasion.

2. Determine optimum packaging, shipping, storage or holding conditions that will maintain initial quality throughout marketing. Particular emphasis should be placed on development of methods to minimize breakage or checking of shell eggs during transit to retail outlets.

3. Develop efficient and effective in-line automatic methods for detection and removal of eggs containing defects such as mottled yolks, different colored yolks, heavy chalazae, meat spots, thin albumen and rots.

B. Ready-to-Cook Poultry:

1. Develop more efficient methods and equipment for catching, hauling, and handling live birds prior to slaughter to reduce the incidence of bruising, to circumvent labor problems, and to minimize the spread of feather, dust, and fecal material during transit to processing plants.

2. Develop improved processing procedures and equipment that will result in reduced bacterial contamination of carcasses and parts. In particular, study alternate methods of scalding, defeathering, and chilling that will minimize cross-contamination and that will not adversely affect quality. Devise more effective equipment and sanitation techniques.

3. Develop new concepts and materials for packaging that will maintain optimum texture and

flavor, retard microbial growth and inhibit oxidative deterioration of poultry carcasses or cut up parts.

4. Evaluate the effect of new or proposed commercial methods of scalding, defeathering, chilling, cutting, freezing, and packaging on physical appearance, juiciness, tenderness, moisture absorption, yield and shelf life of poultry carcasses and cut up parts.

5. Devise objective methods for evaluating carcass quality.

Title: Safety and Wholesomeness of Poultry and Egg Products.

Situation: Poultry and egg products have frequently been implicated as real or potential vehicles of infection or toxins to humans. Opportunities exist in the production-processing-marketing chain for these products to become contaminated with micro-organisms of public health significance such as salmonellae, clostridia, and staphylococci, as well as with residues from pesticides and other chemical compounds, toxic minerals or other environmental contaminants. The use of some additives in foods is now being carefully scrutinized by the Food and Drug Administration. Consequently, it is imperative that the poultry and egg industries be provided with definitive research data regarding the necessity, efficacy, and the safety of all food additives being used or proposed for use in their products. Information regarding the degree to which microbial and chemical contaminants are found in poultry and egg products, their mode of entry, and their real or potential significance as public health hazards is sorely lacking. More effective means for minimizing the incidence of and preventing dissemination of harmful micro-organisms during processing need to be developed. Also needed are rapid, reliable tests for detecting significant levels of harmful micro-organisms or hazardous chemical contaminants in all poultry and egg products.

Objective: To provide maximum assurance that poultry and egg products do not constitute a hazard to human health.

Research approach:

A. Develop improved methods for transporting and handling live birds to reduce the incidence of infected or contaminated birds entering slaughtering plants.

B. Develop new or improved methods for slaughtering, defeathering, eviscerating, chilling, and packaging of poultry that will prevent the spread and growth of harmful micro-organisms and/or formation of microbial toxins.

C. Develop safe, effective physical and/or chemical treatments for destroying harmful micro-organisms on or in poultry and egg products and, concurrently, develop suitable packaging techniques to avoid recontamination during marketing.

D. Evaluate the reliability of present methods of residue analysis and develop new methods for field use to detect significant levels of residues of pesticides, antibiotics, arsenicals and other medicants, toxic metals, etc. in poultry and egg products.

E. Develop improved processing or marketing technology that will obviate the need for suspect food additives.

F. Determine how, where, and to what extent heavy metals, organic chemicals, and other environmental contaminants contaminate poultry and egg products. Where such compounds are found to be a real or potential problem, devise methods for preventing such contamination.

Title: Expanded Markets for Poultry and Eggs Through Development of New and Improved Processed Poultry and Egg Products.

Situation: The poultry and egg industry has been confronted frequently with periods of production exceeding amounts that could be marketed at a profit. Diversification of the food products that can be fabricated from these two nutritious commodities would help to level out supply and demand and ameliorate economic distress; moreover, it would improve the nutritional quality and desirability of the available national diet. Development of new convenience poultry and egg

products is hampered by lack of basic knowledge of the constituents, limited technological effort toward the development of new products, and inadequate promotional efforts.

Many excellent precooked poultry products are now marketed, but most are definitely inferior to their freshly cooked counterparts. Suboptimum low grade use of bony parts and deboned, comminuted poultry meat is widespread in the industry. While many convenience products containing further processed egg have been developed in the laboratory, few have had appreciable success in the market place.

Objective: Provide the basic knowledge and technology essential to the development of a wide range of further processed poultry and egg products.

Research approach:

A. Improve acceptability and stability of precooked poultry products by:

1. Modifications in cooking procedures,
2. Additions of flavor and texture stabilizers,
3. Improved packaging and storage procedures.

B. Develop more profitable food uses for bony parts of the poultry carcass such as backs and necks by:

1. Improved deboning procedures,
2. New sausage-type products from deboned meat,
3. New combination products from deboned meat, eggs, and cereals.

C. Develop improved rolls from poultry meat pieces by combinations of superior binding agents and cooking procedures.

D. Stabilize color of precooked poultry through basic studies of reactions involved in off-color development.

E. Investigate and eliminate obstacles to retail distribution and household use of dried eggs and dried egg containing products.

PRODUCTION ECONOMICS AND MARKETING

The economics of poultry and egg production and marketing have become more important as the industry becomes more specialized and more highly organized. Fewer but larger firms have a relatively greater stake in the correctness of decision-making. Also, there is now greater emphasis on "total system" approaches instead of segmental approaches to production and marketing problems.

Research needs in this area may be grouped into two broad areas with more specific research approaches listed under each. Specific research approaches suggested do not comprise a priority ranking but merely suggest possible avenues of investigating the many varied economic problems facing the industry. The payoffs from these suggested approaches would vary according to size of firm and acuteness of problems faced by firms. Institutional researchers may engage in studies which are considered more "basic" while researchers with private firms may engage in more "applied" types of research.

Information is needed on factors influencing the demand for poultry and eggs. Considerable emphasis should be placed on marketing problems and price controls. Continued work is needed on the economic efficiency of various production systems, particularly in relation to the environmental and economic situation in the Southern Region.

Title: Improvement in the Production Efficiency of Poultry and Eggs.

Situation: As changes take place in the poultry industry, the manner in which the various production aspects are put together and organized in order to minimize costs or maximize profits may change. The current interest in organizing the producer segment of the poultry industry may well dictate that companies should own most or all of their production facilities rather than contract for them. These possible changes should be anticipated and thorough studies conducted before the decisions need to be made. The economist is in a position to establish model organizations or systems and evaluate these. The impact of change on the industry must be studied and projected if the industry is to remain competitive with other meats and other good products.

Although it is possible that there may be only slight reductions in costs of production from studies conducted within this framework, the benefits, when spread over many units, may be large in total and will assist in maintaining efficiency and the competitive position of the industry. Also, cost reductions are likely to accrue to consumers in the form of lower retail prices.

Objective: To improve the production efficiency of poultry and eggs through cost reductions and optimum location of production units and factors.

Research approach: Possible research approaches might include, but not necessarily be restricted to, the following:

A. Design least-cost poultry and egg production systems in terms of locations, size of units, housing, financing, credit, transportation, and other related factors.

B. Evaluate alternative systems related to environmental management and control such as waste handling, cage confinement of broilers and layers and environmentally-controlled housing.

C. Determine break-even points between contract poultry and egg production versus company-owned production.

D. Evaluate probable impacts of anticipated technological developments in the poultry and egg industry.

E. Project the economic and technological consequences of possible disintegration in the poultry and egg industry and a return to independent operations.

F. Appraise the varied aspects of poultry and egg contracting in terms of producers' returns, equity and bargaining power relative to integrators and to devise appropriate model contracts.

G. Analyze the consequences of possible further integration in the poultry and egg industry and to determine the structures and scope of such further integration.

H. Analyze the sources of and arrangements for credit and financing of the poultry and egg industry.

I. Analyze the comparative advantages of poultry and egg production by states and regions of the U.S. together with North American areas of production (Canada and Mexico).

J. Analyze the management and corporate structures of integrated firms in the poultry and egg industry and their effects on costs and efficiency.

K. Simulate vertically integrated operations in the poultry and egg industry.

L. Evaluate the costs of leasing facilities versus ownership costs at all appropriate levels or stages of the poultry and egg industry.

M. Appraise optimum culling or replacement rates for layers with projections for varying economic conditions.

N. Analyze the economics of procurement of production inputs such as chicks, feed, labor, insurance and equipment in terms of productive performance and costs.

O. Analyze labor performance and efficiency at different segments or points in the production process.

Title: Facilitating Movement of Poultry and Eggs Through Marketing Channels.

Situation: Much of the consumer preference research now being done is conducted by industry and the findings are not made public. Results from this type research apply only to individual firms and their market outlets. However, the total industry is in serious need of knowing about many practices that can only be determined by such research. Utilization of the federal and state resources available for such work would permit studies on a sufficiently large scale to be meaningful. To be meaningful, test marketings of new packaging or new products should be conducted in several different markets spread over a wide geographical area. The philosophy that there is under-consumption instead of over-production would indicate that much needs to be done in the marketing and consumption areas.

The benefits to be derived from research in the area of poultry and egg marketing would not necessarily involve cost savings for the industry, but would give a supply of a higher quality

product more tailored to the needs and desires of consumers. This should increase the volume sold at the same or higher prices which would have a stabilizing effect on the industry. The consumers or final users would be the primary receiver of the benefits in that their needs and desires would be more effectively met.

The studies visualized in such an effort would involve the poultry economists of the entire region if the objective of this project is to be realized.

Objective: To expedite the preparation, movement and exchange of poultry and eggs and their products from production units to final consumers or users.

Research approach:

A. Ascertain various aspects of consumer preferences, demands and choices for poultry and eggs and their products for different geographic areas of the United States.

B. Analyze the stated consumer preferences, demands and choices in terms of their economic feasibility for satisfaction of consumer desires. (Cartons, grades, sizes, packaging, preparation).

C. Analyze the "retailer" segment of poultry and egg marketing in terms of costs, efficiency, vertical integration, contracting and pricing methods. ("Retailer" segment here also includes hotels, restaurants and institutional markets as final retailers of poultry and eggs.)

D. Analyze the "wholesaler" segment of poultry and egg marketing in terms of costs, efficiency, vertical integration, contracting and pricing methods.

E. Analyze the "packer" segment of poultry and egg marketing in terms of costs, efficiency and distributive channels (brokers versus company-owned distributors) and compare the costs and efficiency of packing eggs on-farm versus off-farm.

F. Design least-cost marketing systems in terms of packing, hauling and exchanging poultry and eggs and their products from production to final consumer.

G. Analyze the efficiency, equity and effectiveness of the pricing system for poultry and eggs and their products and recommend appropriate improvements including analysis of hedging and future trading therein.

H. Analyze the effectiveness of and feasibility for the promotion of poultry and eggs using various checkoff and funding methods and appraise the effectiveness of varied advertising media.

I. Analyze the role and effectiveness of cooperative marketing and distribution among producers, integrators, marketers and retailers of poultry and eggs (e.g., United Egg Producers and National Broiler Marketing Cooperative).

J. Conduct varied merchandising and pricing experiments with respect to poultry and eggs at the retail or consumer level to determine feasible merchandising, pricing and marketing practices.

K. Project U.S. and regional population growth and migratory trends and relate them to poultry and egg demands assuming varying per capita consumption rates.

L. Project foreign demand and export-import trade for poultry and eggs together with analysis of existing and probable trade barriers.

M. Ascertain optimum marketing procedures and arrangements for fowl, including further processing.

N. Develop new or expand market outlets for poultry and eggs (e.g., egg omeleterias and frozen broilers).

O. Appraise the development of new marketing structures such as contract marketing, joint ventures and forward pricing with chain food stores.

P. Evaluate the transportation economics and costs of assembling, hauling, and delivering, including losses therefrom, for poultry and eggs and their products.

Q. Evaluate the impacts of producer bargaining associations on the size, location and structure of the poultry and egg industry.

R. Analyze the economic impacts of restricting the supply of poultry and eggs on producers, agribusiness suppliers, marketers and consumers utilizing:

1. Marketing orders
2. Supply controls
3. Marketing boards

GENETICS AND BREEDING

The addition of highly trained geneticists to the staffs of both meat and egg chicken breeders, as well as turkey breeders, has insured the pursuit of active research programs, theoretical and applied, by both industry and institutional scientists. To avoid duplication, free cooperation between these groups would be beneficial. To minimize duplication, the institutional geneticist has tended to shift to the identification and synthesis of hereditary determinants (DNA, RNA) and to cellular environments and interactions.

The problem areas identified in the following abbreviated discussion will consist of three categories. (1) Quantitative genetics which because of its mathematical complexity has been largely relegated to the use of the computer. (2) Physiological or form-functional genetics which has been heavily concerned with genetic and gene-environment interactions. (3) Developmental and/or biochemical genetics which has been involved in working out some of the intricate biochemical interrelationships between the gene systems that result in superior genetic stocks.

Most modern breeding systems involve these three types of genetic programs in varying proportions.

Sharing of Responsibility—Special lines like the Florida heat tolerance, Cornell low arginine and the Texas and Alabama blood antigen lines should be continued as long as needed by these institutions. Similarly, lines needed to study modes of inheritance of economic traits, as well as genetic-environmental interactions, could well be developed by the institutional geneticists. However, it is expected that new breeding lines for commercial release will no longer be attempted by such institutions.

Identification of Problem Areas—Recommendations (1971) of the Research Council of the Poultry and Egg Institute of America and the 1971 Report from the Southern Regional Science and Education Workshop identify a number of problems of direct or indirect genetic origin. A non-controversial list of these with high priority includes: (1) disease resistance, particularly leukosis, mycoplasmosis, fowl cholera and salmonellosis; (2) genetic resistance to stress; (3) testing economic potential of dwarf stock, especially broiler breeders; (4) altering product content (e.g., cholesterol in eggs), quality or flavor; (5) determining important genetic-nutritional interrelationships; (6) further improvement of egg production, growth, efficiency and livability; and (7) nutritive composition of corn and other feed grains as measured by the performance of broilers, layers and turkeys.

Title: Genetic Improvement of Bird Survival

Situation: In the production of eggs, broilers and turkeys, breeders have gone almost exclusively to the production of lines or strains for crossing to produce the commercial bird. Livability of the final cross is good, but survival of the parent and/or grandparent stock needs improvement. Changes in the housing, feeding and management environments have been so rapid that breeders lack adequate information on the genetic relationships, as well as methods of selecting for maximum adaptation to new and challenging environmental systems. Such genetic experiments have been avoided by institutional geneticists in the past because of the expense and rapid obsolescence of expensive facilities. The time has now arrived when geneticists must enter into such testing programs, either on institutional premises or those of poultry breeders willing and desirous of cooperation. Experiments must be short-term with emphasis on obtaining the maximum information possible.

Such genetic experimental projects would do well to have the cooperative assistance of interdisciplinary researchers, specifically housing engineers, veterinary diagnosticians and computer scientists.

Objective: The objective of this project would of necessity be varied. Maximum livability would be the overall objective, but to attain this objective, many lines and crosses of birds would have to be observed under multiple variants of housing, vaccination systems, nutrition, waste management, lighting, and ventilation rates. Many different feeding rates and programs would need to be tried in combination with the other variables. Causes of mortality would have to be divided into those that were pathological and those due to other causes.

Research approach: At least four separate base projects would be necessary with each of these subdivided into almost unlimited subprojects. Bird populations for these base projects would best be divided into those utilizing (1) commercial layers; (2) broilers and broiler breeders; (3) turkeys; and (4) game birds. The areas for subprojects have already been listed under Objectives. As an example, bird lines should be tested under housing conditions with varying degrees of environmental control; cages versus floor; cage arrangements; varying vaccination programs; a multitudinous variety of diets and feeding programs; a variety of waste management programs; ventilation rates; etc. Almost all of the other research needs enumerated in this Task Force Report could be included, but the major emphasis would be on the interaction of the various genetic lines and crosses to these environmental variants with emphasis on both the parent line and crosses, as well as the commercial bird.

Potential benefits: A conservative estimate of benefits to be derived from lowering the capital investment in birds with which to carry out the various production programs include:

Turkeys:	Increase Breeder Livability, 5%	$ 300,000
	Increase Commercial Livability, 3%	9,000,000
Broilers:	Increase Breeder Livability, 5%	2,000,000
	Increase Commercial Broilers, 1%	4,200,000
Layers:	Increase Breeder Livability, 5%	200,000
	Increase Commercial Layers, 5%	45,000,000
		$ 60,700,000

Thus, the monetary benefits from genetically-lowered mortality alone is conservatively estimated to be one and one-half times the total land-grant university annual budgets for all poultry teaching, research and extension activities.

Research effort: It is estimated that with the full cooperation of the turkey, broiler and layer breeders, the goals previously outlined in this proposal could be realized by the present genetic research staff of six of the states in the Southern Region. It is not proposed that all of the subprojects on livability be incorporated into one overall project, but that individual segments be incorporated into specific state projects. This proposal is meant to be a covering project for this area of research.

Title: Genetic Improvement of Bird Performance Traits, Including Egg Production, Fertility, Hatchability, Egg Size, Body Weight, Rate of Growth, Body Conformation, Feed Efficiency, Product Composition and Uniformity.

Situation: Remarkable genetic progress has been made in the performance of commercial broilers, turkeys and layers. Performance of the available commercial strains and crosses today markedly exceeds that of a few years ago. However, the comparatively low level of performance of the parent and grandparent stocks as contrasted to the commercial bird increases the cost of the commercial chick or poult above a desirable level. Lowering this cost offers a challenge for geneticists and reproductive physiologists employed by breeding firms and institutions alike. Permanency of commercial crosses is a transitory thing, requiring constant testing of new combinations which would hopefully result in the continuous isolation of the most desirable lines in a testing program. Means of propagating top combinations without the segregation allowed by sexual reproduction is an inevitable must for poultry propagation. A successful means of vegetative propagation of birds would accomplish this objective.

Objective: Many individual projects could be prepared by the various state poultry geneticists, but most, if not all, could be covered by one or more of the objectives of this overall project. One major objective of the project would be to select parental lines with genetically-improved performance traits to be used in crossing. The performance traits might include all or any combination of the following traits: (1) egg production, (2) fertility, (3) hatchability, (4) egg size, (5) body weight, (6) rate of growth, (7) body conformation, (8) feed efficiency and (9) product composition. A second major objective would be to test line combinations that would result in commercial birds that would exhibit superior combinations of the traits listed above.

Research approach: Within currently valuable lines, selection for improvement of each of the desired performance traits listed above could result in a reduced cost of the commercial chick or poult. Intermittent with selection for improvement of the various traits would have to be the measurement of their effects upon performance in the final cross. Computer programs would have to be prepared to attempt to estimate the effects of selection upon cross performance. Curiosity and imaginative limitations would be the restrictions upon the scope of the work that could be undertaken in a program such as this. The number of variables to be measured at each Experiment Station location would be a matter of choice depending upon personnel and facilities. Combinations to be tested would be almost unlimited.

Projects would be expected to be grouped into four major areas: (1) broilers, (2) turkeys, (3) layers and (4) game birds.

Potential benefits: Improvements that may be made in performance would have two potential sources of benefit. First, in the parent and grandparent generation through a reduction in the cost of the commercial chick or poult; and second, increase in performance of the commercial bird. Monetarily, these are estimated conservatively in the following table.

Turkeys:	Increase in Performance Breeder Stock, 10%	$ 3,800,000
	Increase in Performance Commercial Stock, 5%	30,000,000
Broilers:	Increase in Performance Breeder Stock, 10%	24,000,000
	Increase in Performance Commercial Stock, 5%	42,000,000
Layers:	Increase in Performance Breeder Stock, 10%	1,200,000
	Increase in Performance Commercial Layers, 10%	165,000,000
		$266,000,000

If these genetic improvements could be realized, they alone would add 6.23 percent per year to the present 4.263 billion dollar U.S. poultry income. Approximately half of this would be added poultry income to the 13 southern states.

Research effort: It is estimated that if the genetic improvements envisioned in this project are realized, the poultry genetics staff of at least seven southern states would be required.

Genetic Teamwork

As an illustration of current modern trends toward a cooperative teamwork approach in genetic research, the following sequence is outlined in some detail simply as an example of the need and reward for "teamwork" research so badly needed in all of agriculture today.

1. Poultry is rapidly moving into environmentally-controlled houses. The cost of such houses demands that birds of a smaller genetic body size be housed at greater density. Cooperation with the agricultural engineer is needed here to provide adequate ventilation, lighting and waste management for this new bird.
2. Smaller body size and greater bird density demand changes in nutrition toward higher density diets. Here, cooperation with the nutritionist becomes essential for low cost production.
3. High densities and more restricted housing impose upon the birds greater disease stress demanding cooperation with the veterinarian or pathologist.

4. Maintaining birds in wire-floored cages or environmentally-controlled broiler houses makes possible higher density and permits reduced housing cost. These, in turn, create more of a cannibalism problem which, in turn, encourages teamwork between the geneticist and the management expert.
5. Modern poultry production practices emphasize least-cost production and not necessarily maximum production. Expertise in this field can best be obtained from an agricultural economist. Thus, the geneticist must enlist another specialist on his team to obtain maximization of profits.
6. It is becoming increasingly clear that the geneticist can no longer isolate himself while he attacks the breeding problems outlined in the proposed project on "Performance." More and more specialists, and especially breeding experts, are finding it necessary to use the services of an increasing number of other areas of expertise to maximize their progress.

The genetic and breeding needs of the poultry industry must be kept in the mind of the individual scientist and his administrators if an institution is to render optimum service to its state, region and nation. This section has attempted to highlight some of the current pressing needs of the poultry industry of the United States and the Southern Region.

APPENDIX

SUMMARY OF POULTRY RESEARCH IN SOUTHERN REGION DURING FISCAL YEAR 1971[1/]

Research Problem Area		Project Count	Total Funds	Total Scientist Man-Years
210	Control of Insects and External Parasites	9	131,781	2.9
211	Control of Diseases	53	1,977,798	33.0
212	Control of Internal Parasites	12	92,950	1.9
213	Protection from Toxic Chemicals, Poisonous Plants and Other Hazards	3	25,670	0.8
214	Protection from Harmful Effects of Pollution	2	25,950	0.8
310	Reproductive Performance	29	415,188	8.6
311	Improvement of Biological Efficiency in Production	84	1,782,337	34.8
312	Environmental Stress in Production	49	1,061,483	17.7
313	Production Management Systems	15	129,965	3.7
409	Production of Products with Improved Acceptability	8	77,972	1.9
410	New and Improved Food Products	22	575,099	8.7
411	New and Improved Non-food Products	2	23,897	0.6
412	Quality Maintenance in Marketing Products	6	102,424	2.2
501	Improvement of Grades and Standards	1	8,506	0.2

Research Problem Area		Project Count	Total Funds	Total Scientist Man-Years
503	Efficiency in Marketing Products and Production Inputs	15	246,617	7.5
506	Supply, Demand and Price Analysis	6	16,199	0.5
507	Competitive Interrelationships	1	28,921	1.8
508	Development of Domestic Markets	3	23,928	0.3
509	Performance of Marketing Systems	1	14,666	1.2
701	Insure Food Products Free of Toxic Residues	8	92,970	2.5
702	Protect Food and Feed Supplies from Harmful Microorganisms and Naturally Occurring Toxins	4	252,773	3.1
708	Human Nutrition	3	82,316	0.8
901	Alleviation of Pollution and Disposal of Wastes	2	231,231	1.6
	Totals	338	7,420,641	137.1

1/ This table was developed from information retrievals from the Current Research Information System (CRIS).

800--8-72